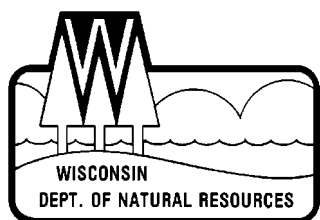




Fall 2001 through Spring 2002



Wisconsin Department of Natural Resources
Bureau of Fisheries Management and Habitat Protection

Root River Steelhead Facility Fall 2001 through Spring 2002

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Abstract – A total of 10,214 chinook salmon, 1,327 coho salmon, 1,793 steelhead and 177 brown trout were examined at the Root River Steelhead Facility during fall, 2001 and spring, 2002. The majority of the chinook (9,698 or 95%) were passed upstream. The remaining 516 were sacrificed after spawning, for disease testing, or were too weak to pass. A total of 942 coho salmon were passed upstream, another 291 were transported to Kettle Moraine Springs Hatchery as broodstock, and the remaining 94 were sacrificed for disease testing, or were too weak to pass. Three hundred twenty-four coho salmon were spawned at the facility and another 291 that were not ripe were held at the hatchery for spawning to produce 800,000 eggs. The fall return of 490 steelhead was higher than recent years. Three hundred fourteen skamania-strain steelhead were identified by fin clips and transported along with seven skamania from the Kewaunee River and milt from 14 Indiana skamania to Kettle Moraine Springs Hatchery as broodstock. Males were in short supply, but 83 females and 44 males were spawned to produce 386,000 fertilized eggs. The remaining 176 steelhead were passed upstream. The bulk of the spring steelhead (1,180 fish) were passed upstream; 587 of these were spawned before passage, while another 121 were sacrificed for health assessment after spawning and two adipose-clipped steelhead were sacrificed to recover coded wire tags. The 708 spawners produced 1,425,000 eggs. One brown trout died in the weir and the remaining 176 were passed upstream. The estimated population of chinook salmon, at 16,792 ($\pm 1,205$ SD), was the second-highest since operations began in 1994. Brown trout (6,336 $\pm 3,607$ SD) were at record levels. The estimated population of coho salmon (1,413 ± 471 SD) was the lowest since 1994. Estimated populations of chambers creek and ganaraska steelhead were 940 (± 198 SD) and 579 (± 115 SD), respectively. Fall steelhead were estimated at 1,794 (± 762 SD).

Cover photo: Satisfied angler displays a steelhead at Kletzsch Park on the Milwaukee River during spring, 1999. Photo by DNR Fisheries Biologist Will Wawrzyn.

The Root River Steelhead Facility (RRSF) is one of three weirs operated by Wisconsin Department of Natural Resources (WDNR) to collect information and broodstock from Lake Michigan trout and salmon. The Strawberry Creek Weir in Sturgeon Bay targets chinook salmon, while the Basadney Area Fishery Facility (BAFF) on the Kewaunee River targets coho salmon and steelhead and the RRSF contributes primarily steelhead. In addition, BAFF and RRSF provide backup collection sites for the other species. Brown trout do not return well to the weir sites, and are collected in the lower reaches of the rivers with a boat electroshocker. Management of trout and salmon in Lake Michigan brood rivers is intended to ensure adequate egg collections, conserve the genetic diversity of feral trout and salmon stocks and provide fishing opportunities. To accomplish these objectives, weir operations follow strategies outlined by WDNR guiding documents (e.g., Ives 1996, WDNR 1999).

The weirs provide a more efficient and reliable method to collect adult salmonids than the portable weirs and electrofishing efforts employed during past years. The RRSF was constructed in 1994 through a cooperative effort by WDNR, Salmon Unlimited, City of Racine and U.S. Fish & Wildlife Service. In addition to providing a collection and processing site for returning adult salmonids, the RRSF provides a unique educational tool for school groups and other interested publics.

This paper reports the results of data collected at the RRSF during fall, 2001 through spring, 2002. These data contribute to a long-term index of chinook, coho and steelhead populations in the Root River, and are collected to fulfill three objectives: 1) track the abundance of salmonid returns, 2) measure growth and condition of each species and/or strain, and 3) estimate return rate of each species.

METHODS

During operation of the weir, a minimum of 100 fish per targeted species and fin clip were sampled, except that only two skamania steelhead were sampled at the weir during fall, 2001 in an effort to reduce stress and mortality on broodstock. Additional skamania data were obtained from Kettle Moraine Springs Hatchery (KMSH). Sampled fish were measured to the nearest millimeter, weighed to the nearest 0.1 pound, examined for fin clips, gender and condition. The remaining fish were tallied by species, gender and fin clip. Gametes were stripped from these fish, if needed. After this initial handling, fish were either held for broodstock, passed upstream or sacrificed (fish health or contaminant samples). All fish passed upstream were given an upper caudal clip for population estimates.

All non-target species or fin clips were tallied by species, fin clip and sex, given an upper caudal clip and passed upstream. All coded wire tagged (CWT) fish are marked by an adipose-only clip, and have a tiny microtag implanted in their heads. The CWT fish were measured, weighed and sacrificed; heads were removed from behind the opercular flap, and frozen for later examination. Fish were collected as needed for other studies including disease or contaminant samples.

Size and condition

Trends in size and condition of all species processed at RRSF are calculated. Only fish with both total length and weight data are included in calculations of trophy weight (95th percentile of the weight distribution), and standard weight (predicted weight at a given length based on a length-weight regression).

Steelhead strain evaluation

Steelhead stocking targets in the Root River were 35,000 per strain until 1999, when chambers creek and ganaraska targets were reduced to 27,000. All steelhead stocked in the broodstock rivers (Root and Kewaunee Rivers) are marked with a fin clip to identify the strain and yearclass. Each strain is assigned three fin clips (two fin clips prior to 1997), which are rotated annually. The three clips allow much cleaner separation of yearclasses than the two-year clip rotation used previously. In addition to their use in identifying fish for breeding purposes, the fin clips allow each strain to be evaluated. This includes age of returning fish, return rates and population estimates by strain.

Population estimates

Fish that are passed by the weir are marked with a caudal (tail) clip, and recaptures of marked fish are noted in the creel survey for a mark-recapture population estimate of the population above the weir. Population

estimates for each species or strain are derived from one of two equations. When sample sizes were adequate, the Petersen equation for mark and recapture was used (Ricker 1975):

$$N = \frac{M * C}{R} \quad (1)$$

Where

N = size of population in the river

M = number of marked fish at large in the river

C = number of recaptured fish

R = number of marked fish in the recapture sample

The sample standard deviation was calculated as:

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R^3}} \quad (2)$$

For species or strains with low sample sizes (i.e., 3 or fewer marked recaptures), the Bailey's modified equation was used for the population estimate (Ricker 1975):

$$N = \frac{M * (C + I)}{R + I} \quad (3)$$

With sample standard deviation:

$$S(N) = \sqrt{\frac{M^2 * (C + I) * (C - R)}{(R + I)^2 * (R + 2)}} \quad (4)$$

RESULTS AND DISCUSSION

The sixth season of operation for RRSF began August 21, 2001 and concluded April 11, 2002. A total of 10,214 chinook, 1,327 coho, 1,793 steelhead and 177 brown trout were examined (Table 1).

Chinook salmon

A record total of 10,214 chinook salmon were examined at RRSF during fall, 2001 (Table 2). A number of chinook were sacrificed for disease testing (60), after spawning (204), contaminants analysis (22), coded wire tags (2) or died in the weir (228). The spawned and sacrificed fish were part of a fish-health survey; eggs for hatchery production were taken at Strawberry Creek near Sturgeon Bay (see Peeters and Royseck 2001). The majority (9,697 or 95%) were passed upstream. A single spring-caught chinook was also passed upstream.

Average weight of chinook salmon was 15.7 pounds, the highest average weight of the period well above the eight-year average of 12.6 pounds (Table 3). Average length, standard weight and trophy weight were also the highest recorded at RRSF.

Coho salmon

During September 11 through November 6, 2001, 1,327 coho salmon were examined at RRSF (Table 4). About half of the coho (618 or 47%) were passed upstream. Two hundred thirty-one were transferred to KMSH to mature for spawning. Another 10 were sacrificed for coded wire tags, 61 for health assessments and 23 died in the weir or were too weak to pass upstream. About 800,000 eggs were taken from 324 coho at the weir. Shortfalls in Wisconsin coho eggs were made up with surplus eggs from Michigan, which experienced coho returns well above average. Age composition (based on length-frequencies) indicated 16% age 1+ and 84% age 2+ (Table 5).

Average coho salmon weight and length declined from the high values of 1999 and 2000, but were the third and second-highest values of the eight-year period, respectively (Table 3). Standard weight and trophy weight were also above average indicating that the coho were both large and healthy.

Steelhead

Weir operations maintained the high effort of recent years to offset declining steelhead returns. A total of 1,793 steelhead were examined at RRSF from August 21, 2001 to April 11, 2002. Most fish (1,356 or 76%) were passed upstream (Table 6). One hundred twenty-one steelhead were sacrificed for disease testing and two for coded wire tags. In addition, 314 skamania-strain steelhead were transported as broodstock to KMSH during late summer and fall, along with seven fish from BAFF and milt from 14 Indiana male skamania. The Indiana milt was intended to augment the genetic diversity of Wisconsin's feral skamania population by splitting the eggs of individual Wisconsin females and mating half with a Wisconsin male and half with an Indiana male skamania. However, low numbers of males in both states and poor milt production by some skamania males resulted in some males being mated with more than one female. Eighty-three female skamania were mated with 30 Wisconsin males and 14 Indiana males. The remaining females were not spawned. Egg collections totaled 386,000 skamania, 675,000 chambers creek and 750,000 ganaraska. After egg collections were completed, 109 female skamania were released to the Sheboygan River.

During most years, age 3 and 4 fish contribute the bulk of the steelhead run. Comparing among yearclasses with data through age 4, cumulative return of fall skamania to the weir was only around 0.35% for the 1995 and 1996 yearclasses and 0.13% for the 1997 yearclass, compared to 0.68% to 2.35% for 1991 through 1994 yearclasses (Table 7). The spring returns have been stronger, but the spring return-rate of the 1997 yearclass, at 0.66%, was over 50% lower than the next lowest yearclass (Table 7). A strong return from the 1998 yearclass helped offset the poor performance of the 1997's.

Management actions to address the decline in steelhead broodstock that have been implemented include: increased weir operations, collection of additional broodstock by electroshocking when shortfalls are projected, fin clipping of nearly all steelhead, inoculation of adult skamania against disease, and addition of skamania gametes from other sources to increase genetic diversity. A reduction in angler bag limits either below the weirs or in all Wisconsin waters of Lake Michigan was considered, but was postponed in the hope that other actions will be sufficient. A steelhead research agenda is under development.

Steelhead strain evaluation

The percent age composition of the runs was assigned from age-length keys developed from 209 fall fish and 457 known-age (fin clipped) spring fish. Of 209 fish aged during fall, 164 were skamania held at KMSH before being weighed and measured. The KMSH data are used to estimate age composition (Table 8) and for average skamania length and weight at age (Table 9) but are excluded from season-wide averages (Table 3). Age 1 represent 2.4% of the fall sample, 2 are 1.4%, 3 are 72.8%, 4 are 1.5%, 5 are 13.3%, 6 are 26.3% and 7 are 7.0%. During spring, age 2 represent 4.2% of the return, 3 are 23.2%, 4 are 68.3%, 5 are 1.5%, 6 are 0.8% and 7 are 2.0% (Table 8). The low fall return of age 4 skamania again highlights the poor performance of the 1997 yearclass.

Fall skamania tend to have higher average length and weight than spring steelhead of the same age, but are comparable to spring fish one year older (Tables 9, 10, 11, Figures 1, 2). This is probably because a given-age fish in fall will be classified one year older the following spring, but puts on little growth during the winter months. Chambers creek steelhead averaged slightly longer and heavier than ganaraska, especially at younger ages. This could be due to either higher growth rates for chambers creek, or perhaps only relatively large chambers creek steelhead make a spawning run.

Population estimates

The number of chinook handled at the weir during 2001 was a record 10,213 (Table 1), and the population estimate of 16,792 ($\pm 1,205$ SD) was second only to 2000 (Table 11). The coho estimate of 1,413 (± 471 SD) was the lowest on record (excluding 1994, when too few coho were recaptured to generate an estimate). Skamania comprised 85% of the fall steelhead encountered at the weir. If 85% of the fall steelhead population (estimated at $1,794 \pm 762$ SD) is combined with 314 removed to KMS hatchery, then about 1,478 skamania returned during fall, 2001. This is the highest estimated return of skamania since

1996. Chambers creek were estimated at 940 (\pm 198 SD), while the ganaraska estimate was 579 (\pm 115 SD). The higher number of chambers creek compared to ganaraska steelhead reverses a recent trend of strong ganaraska runs and poor chambers creek returns. The spring steelhead population estimates are lower than optimal, but stable flows and a strong effort by DNR staff allowed adequate numbers of broodstock to be recovered.

REFERENCES

Hogler, S. and S. Surendonk. 2002. Return, size, and age of steelhead at the Besadney Anadromous Fisheries Facility, 2001. Wisconsin Department of Natural Resources. Madison, WI. 23 pages.

Ives, D. 1996. Anadromous feral broodstock protocol. Wisconsin Department of Natural Resources. Madison, WI. 2 pages.

Peeters, P. and K. Royseck 2001. Harvest, age and size at age of chinook and coho salmon at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility, Fall 2000. Wisconsin Department of Natural Resources. Madison, WI. 64 pages.

Ricker, 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191. Department of the Environment, Fisheries and Marine Service. Ottawa, Canada. 382 pages.

Wisconsin Department of Natural Resources (WDNR). 1999. Lake Michigan steelhead fisheries management plan 1999. Wisconsin Department of Natural Resources. Madison, WI. Administrative Report 44. 19 pages.

Table 1. Summary of chinook salmon, coho salmon, steelhead and brown trout captured at the Root River Steelhead Facility during 1994 to 2002.

CHINOOK SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	129	1,726	3	1,858
Fall, 1995	300	2,663	16	2,979
Fall, 1996	62	5,440	87	5,589
Fall, 1997	0	3,974	128	4,102
Fall, 1998	67	3,845	65	3,977
Fall, 1999	221	5,381	420	6,022
Spring, 2000	0	7	0	7
Fall, 2000	244	6,965	166	7,375
Fall, 2001	432	9,697	84	10,213
Spring, 2002	0	1	0	1

COHO SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	285	513	15	813
Fall, 1995	1,191	2,115	15	3,321
Fall, 1996	161	3,940	305	4,406
Fall, 1997	655	6,909	330	7,894
Fall, 1998	328	3,336	336	4,000
Fall, 1999	154	978	18	1,150
Fall, 2000	472	2,921	15	3,408
Fall, 2001	314	942	71	1,327

STEELHEAD

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	218	583	47	848
Spring, 1995	120	2,582	18	2,720
Fall, 1995	330	208	0	538
Spring, 1996	150	2,970	49	3,169
Fall, 1996	248	105	0	353
Spring, 1997	2	2,918	125	3,045
Fall, 1997	408	228	8	644
Spring, 1998	0	382	0	382
Fall, 1998	86	64	1	151
Spring, 1999	0	2,131	132	2,263
Fall, 1999	50	19	1	70
Spring, 2000	0	2,107	64	2,171
Fall, 2000	160	59	0	219
Spring, 2001	63	790	6	859
Fall, 2001	314	176	0	490
Spring, 2002	0	1,180	123	1,303

BROWN TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	0	259	0	259
Fall, 1995	46	645	0	691
Spring, 1996	0	4	0	4
Fall, 1996	70	244	0	314
Spring, 1997	0	2	0	2
Fall, 1997	114	369	3	486
Spring, 1998	0	2	0	2
Fall, 1998	14	202	12	228
Fall, 1999	0	125	0	125
Spring, 2000	0	6	0	6
Fall, 2000	2	241	0	243
Spring, 2001	0	2	0	2
Fall, 2001	1	176	0	177

Table 2. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2001 and spring, 2002.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
21-Aug-2001	0	34	0	34
24-Aug-2001	0	56	0	56
27-Aug-2001	0	56	0	56
31-Aug-2001	3	9	0	12
11-Sep-2001	2	120	22	144
14-Sep-2001	1	278	0	279
20-Sep-2001	4	810	0	814
21-Sep-2001	3	246	0	249
24-Sep-2001	8	794	0	802
26-Sep-2001	5	1,008	0	1,013
28-Sep-2001	8	776	1	785
01-Oct-2001	5	416	0	421
03-Oct-2001	1	46	60	107
04-Oct-2001	277	641	0	918
05-Oct-2001	0	469	0	469
08-Oct-2001	18	587	0	605
11-Oct-2001	47	1,354	0	1,401
12-Oct-2001	0	696	0	696
15-Oct-2001	21	591	0	612
18-Oct-2001	6	139	0	145
22-Oct-2001	8	352	1	361
25-Oct-2001	5	115	0	120
01-Nov-2001	6	95	0	101
06-Nov-2001	4	9	0	13
11-Mar-2002	0	1	0	1
Totals	432	9,698	84	10,214

Table 3. Average weight, average length, standard weight and trophy (95th percentile) weight for the major salmonid species returning to the Root River Steelhead Facility during 1994 to 2002.

Season	Number used in analysis	Average weight (pounds)	Average length (inches)	Standard weight	Trophy weight
CHINOOK SALMON					
1994 – 95	343	8.9 ± 5.3	27.7 ± 5.6	9.7	17.8
1995 – 96	443	12.0 ± 5.9	30.7 ± 5.2	10.1	21.0
1996 – 97	703	11.7 ± 5.7	30.7 ± 5.4	9.8	21.1
1997 – 98	490	12.7 ± 4.9	32.5 ± 4.4	9.5	21.1
1998 – 99	389	12.2 ± 5.0	31.9 ± 4.3	9.5	19.6
1999 – 2000	418	13.2 ± 4.4	32.5 ± 3.8	9.9	19.9
2000 – 01	536	12.3 ± 5.7	31.1 ± 5.7	9.7	20.0
2001– 02	672	15.7 ± 5.2	34.3 ± 4.3	10.3	23.5
COHO SALMON					
1994 – 95	208	1.5 ± 1.1	15.9 ± 2.5	3.7	3.0
1995 – 96	594	3.1 ± 2.5	19.6 ± 5.1	3.6	9.0
1996 – 97	1,273	5.1 ± 2.4	23.9 ± 4.7	3.5	8.3
1997 – 98	828	3.8 ± 1.7	21.8 ± 3.5	3.5	6.7
1998 – 99	477	4.3 ± 1.7	23.4 ± 3.1	3.4	7.5
1999 – 2000	338	7.1 ± 4.4	25.5 ± 5.9	4.0	13.5
2000 – 01	472	8.2 ± 2.5	27.3 ± 3.2	3.9	11.6
2001– 02	316	6.8 ± 2.9	25.9 ± 4.9	3.7	10.3
STEELHEAD					
1994 – 95	638	5.9 ± 2.8	25.4 ± 4.7	3.5	10.7
1995 – 96	963	6.2 ± 2.7	25.6 ± 4.3	3.7	11.0
1996 – 97	626	7.2 ± 2.4	27.4 ± 3.3	3.6	11.2
1997 – 98	522	5.8 ± 2.9	25.7 ± 4.9	3.4	11.2
1998 – 99	603	6.2 ± 2.0	25.9 ± 3.3	3.9	9.8
1999 – 2000	766	7.3 ± 2.5	27.2 ± 3.9	3.6	11.0
2000 – 01	482	5.0 ± 1.7	24.1 ± 2.7	3.7	8.4
2001– 02	674	6.9 ± 2.4	26.9 ± 3.7	3.6	10.5
BROWN TROUT					
1994 – 95	108	4.9 ± 1.5	22.1 ± 2.7	3.4	7.0
1995 – 96	201	5.3 ± 2.2	22.4 ± 3.3	3.6	9.0
1996 – 97	162	4.6 ± 2.1	21.4 ± 4.0	3.4	7.8
1997 – 98	250	6.7 ± 3.4	24.0 ± 3.7	3.8	14.1
1998 – 99	55	6.6 ± 3.2	24.3 ± 3.5	3.5	13.5
1999 – 2000	120	6.7 ± 2.6	23.9 ± 3.7	3.5	10.1
2000 – 01	0				
2001– 02	95	5.2 ± 1.8	21.9 ± 3.1	3.7	8.2

Table 4. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2001.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
21-Aug-2001	0	0	0	0
24-Aug-2001	0	0	0	0
27-Aug-2001	0	0	0	0
31-Aug-2001	0	0	0	0
11-Sep-2001	0	3	0	3
14-Sep-2001	0	4	1	5
20-Sep-2001	0	36	0	36
21-Sep-2001	0	2	0	2
24-Sep-2001	0	67	1	68
26-Sep-2001	0	72	2	74
28-Sep-2001	0	21	1	22
01-Oct-2001	18	0	0	18
03-Oct-2001	0	0	0	0
04-Oct-2001	4	8	0	12
05-Oct-2001	0	117	0	117
08-Oct-2001	69	18	1	88
11-Oct-2001	108	9	1	118
12-Oct-2001	92	80	0	172
15-Oct-2001	0	11	0	11
18-Oct-2001	0	26	3	29
22-Oct-2001	3	135	0	138
25-Oct-2001	4	159	0	163
01-Nov-2001	15	160	61	236
06-Nov-2001	1	14	0	15
Totals	314	942	71	1,327

Table 5. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility during fall, 1994 through 2001. During 1994 to 1998, age was based on age-length key developed from known-age fin-clipped coho salmon. After 1998, ages were assigned by length-frequency of measured fish.

Year of Return	Percent age composition		Number used in analysis	Total return
	1+	2+		
1994	53 %	47 %	485	813
1995	24 %	76 %	1,349	3,321
1996	32 %	68 %	4,170	4,406
1997	5 %	95 %	6,978	7,894
1998	12 %	88 %	2,439	4,000
1999	44 %	56 %	341	1,150
2000	7 %	93 %	472	3,408
2001	16 %	84 %	320	1,327

Table 6. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2001 and spring, 2002.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
21-Aug-2001	26	20	0	46
24-Aug-2001	74	22	0	96
27-Aug-2001	17	9	0	26
31-Aug-2001	7	5	0	12
11-Sep-2001	13	11	0	24
14-Sep-2001	12	5	0	17
20-Sep-2001	36	13	0	49
21-Sep-2001	0	1	0	1
24-Sep-2001	24	6	0	30
26-Sep-2001	13	7	0	20
28-Sep-2001	26	13	0	39
01-Oct-2001	28	6	0	34
03-Oct-2001	0	0	0	0
04-Oct-2001	3	1	0	4
05-Oct-2001	0	1	0	1
08-Oct-2001	7	3	0	10
11-Oct-2001	4	3	0	7
12-Oct-2001	2	4	0	6
15-Oct-2001	0	0	0	0
18-Oct-2001	2	2	0	4
22-Oct-2001	4	10	0	14
25-Oct-2001	10	14	0	24
01-Nov-2001	6	19	0	25
06-Nov-2001	0	1	0	1
11-Mar-2002	0	184	62	246
19-Mar-2002	0	387	0	387
28-Mar-2002	0	339	0	339
02-Apr-2002	0	122	61	183
11-Apr-2002	0	148	0	148
Totals	314	1,356	123	1,793

Table 7. Return rate of steelhead to the Root River Weir during 1994 through 2002. Number at age were estimated by expanding the proportion at each age in the aged sample against the return of known-strain steelhead. Fall data include only skamania; spring data combine chambers creek and ganaraska returns.

year	number	return	Number at age							total	return
class	stocked	time	age 1	age 2	age 3	age 4	age 5	age 6	age 7		rate
1991	39383	fall			341	241	109	27	0	719	1.82%
	71229	spring				1151	248	255	1	1655	2.32%
	110,612	total	0	0	341	1392	357	282	1	2373	2.15%
1992	35276	fall		60	106	16	60	1	0	241	0.68%
	65744	spring			949	900	544	16	0	2410	3.67%
	101,020	total	0	60	1055	916	604	17	0	2651	2.62%
1993	30,417	fall	70	59	125	417	22	4	19	716	2.35%
	69,883	spring		222	983	1024	17	0	0	2246	3.21%
	100,300	total	70	282	1108	1440	39	4	19	2962	2.95%
1994	37,347	fall	76	78	87	37	3	14	10	306	0.82%
	72,313	spring		299	534	116	133	45	1	1129	1.56%
	109,660	total	76	377	621	154	136	59	12	1435	1.31%
1995	34,254	fall	0	27	25	31	12	39		135	0.39%
	69,983	spring		25	111	807	216	19	21	1199	1.71%
	104,237	total	0	52	136	838	228	59	21	1334	1.28%
1996	35,262	fall	0	0	18	84	20			121	0.34%
	70,225	spring		47	850	815	10	9		1731	2.47%
	105,487	total	0	47	867	899	30	9		1853	1.76%
1997	37,484	fall	0	0	46	5				50	0.13%
	66,735	spring		38	323	61	18			441	0.66%
	104,219	total	0	38	369	66	18			491	0.47%
1998	35,528	fall	0	5	231					236	0.66%
	53,914	spring		122	578	723				1423	2.64%
	89,442	total	0	127	809	723				1659	1.85%
1999	37,010	fall	0	5						5	0.01%
	54,405	spring		25	245					270	0.50%
	91,415	total	0	29	245					275	0.30%
2000	35,247	fall	8							8	0.02%
	54,160	spring		42						42	0.08%
	89,407	total	8	42						50	0.06%

Table 8. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility during 1994 – 2002. Age is based on age-length key developed from known-age fin clipped steelhead. Total number represents the number of steelhead used in the analysis. During 2000 and 2001, data from skamania transported to Kettle Moraine Springs Hatchery are included.

Year of return	Percent age composition							Total number
	1+	2+	3+	4+	5+	6+	7+	
Fall – 1994	8.9	7.5	43.2	34.2	6.2	-	-	146
Spring – 1995		7.3	31.3	38.0	12.7	10.7	-	450
Fall – 1995	15.6	12.2	21.8	49.7	0.7	-	-	147
Spring – 1996		11.0	36.1	33.1	9.1	10.1	0.6	692
Fall – 1996	-	26.3	36.8	5.3	31.6	-	-	21
Spring – 1997		1.0	22.1	42.5	22.5	10.5	1.4	483
Fall – 1997	-	4.4	14.2	67.2	9.6	4.4	-	135
Spring – 1998		15.3	35.9	37.6	5.6	5.2	0.4	287
Fall – 1998	-	-	29.3	44.0	25.3	1.4	-	75
Spring – 1999		2.1	46.5	44.2	7.3	-	-	385
Fall – 1999	-	-	32.3	54.7	5.2	7.8	-	51
Spring – 2000		8.0	21.3	53.6	14.2	3.0	-	714
Fall – 2000	-	2.7	25.3	46.7	6.7	8.0	10.7	75
Spring – 2001		3.5	83.2	8.9	1.4	2.8	0.2	482
Fall – 2001	2.4	1.4	72.8	1.5	13.3	26.3	7.0	212
Spring – 2002		4.2	23.2	68.3	1.5	0.8	2.0	575

Table 9. Average length and weight at age (± 1 SD) of fall-run skamania-strain steelhead at the Root River Steelhead Facility during 1994 to 2001. Data from 2000 and 2001 were taken from fish transported and held at Kettle Moraine Springs Hatchery, so some weight loss likely occurred.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Fall, 1994	Skamania	23.6 (± 0) 4.5 (± 0) N = 1	26.1 (± 1.8) 5.6 (± 1.1) N = 52 / 43	29.9 (± 1.8) 8.3 (± 1.5) len N = 40 wt N = 31	31.9 (± 2.7) 10.2 (± 2.2) len N = 13 wt N = 12	33.6 (± 1.0) 11.6 (± 1.3) N = 11	
Fall, 1995	Skamania	25.8 (± 1.0) 5.3 (± 0.8) N = 14	27.0 (± 1.5) 6.2 (± 1.1) N = 27	30.5 (± 2.0) 9.1 (± 2.1) N = 70	31.7 (± 1.1) 10.5 (± 1.4) N = 6		
Fall, 1996	Skamania	22.1 (± 0) 4.0 (± 0) N = 1	27.2 (± 1.4) 6.7 (± 0.7) N = 7	28.8 (± 0) 8.0 (± 0) N = 1	32.1 (± 1.7) 10.1 (± 1.8) N = 2		
Fall, 1997	Skamania	28.5 (± 1.0) 7.1 (± 0.9) N = 6	27.1 (± 1.1) 6.0 (± 1.0) len N = 19 wt N = 18	31.1 (± 1.8) 9.1 (± 1.9) N = 91	32.1 (± 1.3) 9.6 (± 1.1) N = 12	34.5 (± 1.7) 12.3 (± 3.3) N = 7	36.0 (± 0) 12.9 (± 0) N = 1
Fall, 1998	Skamania		25.8 (± 1.4) 5.1 (± 0.8) N = 22	30.0 (± 2.1) 8.0 (± 1.6) N = 44	31.9 (± 2.0) 9.5 (± 1.5) N = 19		
Fall, 1999	Skamania		28.3 (± 1.6) 7.3 (± 0.8) N = 14	29.0 (± 1.2) 8.0 (± 1.1) N = 25	31.6 (± 2.1) 10.6 (± 0.4) N = 2	32.2 (± 0.6) 10.0 (± 1.1) N = 4	
Fall, 2000	Skamania	26.4 (± 0) 7.0 (± 1.4) N = 2	27.8 (± 1.2) 7.5 (± 1.0) N = 19	30.2 (± 2.0) 8.5 (± 2.0) len N = 37 wt N = 38	28.9 (± 0.5) 8.6 (± 1.0) N = 8	31.2 (± 1.0) 10.6 (± 1.8) N = 6	32.3 (± 2.3) 10.1 (± 1.8) N = 8
Fall, 2001	Skamania		27.0 (± 1.3) 6.8 (± 1.1) len N = 135 wt N = 53	25.5 (± 0.6) 6.6 (± 0.2) len N = 3 wt N = 2	31.5 (± 1.4) 9.3 (± 1.5) len N = 5 wt N = 3	30.5 (± 1.1) 10.1 (± 1.9) len N = 15 wt N = 10	32.6 (± 1.6) 10.9 (± 1.3) len N = 7 wt N = 5

Table 10. Average length and weight at age (± 1 SD) of spring-run chambers creek-strain steelhead at the Root River Steelhead Facility during 1995 to 2002.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Spring, 1995	Chambers Cr.	20.9 (± 1.1) 4.2 (± 1.1) N = 3	23.9 (± 1.7) 4.6 (± 1.1) N = 73	28.1 (± 1.4) 7.6 (± 1.2) N = 89	28.5 (± 1.4) 7.8 (± 1.3) N = 32	31.3 (± 0.9) 10.0 (± 1.1) N = 25	
Spring, 1996	Chambers Cr.	18.5 (± 0.8) 2.2 (± 0.3) N = 22	25.2 (± 1.4) 5.6 (± 1.1) N = 87	27.9 (± 1.4) 7.4 (± 1.2) N = 90	29.5 (± 1.8) 9.3 (± 1.6) N = 52	31.2 (± 1.3) 10.5 (± 1.5) N = 41	32.0 (± 0.6) 12.0 (± 0.7) N = 3
Spring, 1997	Chambers Cr.		24.8 (± 1.3) 5.3 (± 1.0) N = 33	28.6 (± 1.9) 8.3 (± 1.5) N = 77	27.4 (± 1.6) 6.6 (± 1.5) N = 70	32.2 (± 1.1) 11.2 (± 1.6) N = 35	
Spring, 1998	Chambers Cr.		23.8 (± 1.4) 4.3 (± 0.8) N = 42	27.7 (± 2.3) 7.0 (± 2.0) N = 39	28.9 (± 1.8) 7.5 (± 1.2) N = 5	32.1 (± 0.8) 10.2 (± 1.3) N = 7	
Spring, 1999	Chambers Cr.	18.6 (± 0.4) 2.7 (± 0.8) N = 2	23.8 (± 1.6) 4.7 (± 0.8) N = 13	28.3 (± 2.0) 7.6 (± 1.3) N = 96	28.6 (± 2.3) 8.0 (± 1.8) N = 4		
Spring, 2000	Chambers Cr.	17.2 (± 1.1) 1.6 (± 0.3) N = 12	26.2 (± 1.8) 6.3 (± 1.1) N = 26	29.3 (± 1.8) 8.3 (± 1.4) N = 90	29.8 (± 2.2) 8.7 (± 1.8) N = 54	30.3 (± 1.5) 8.6 (± 1.9) N = 8	
Spring, 2001	Chambers Cr.		23.9 (± 1.6) 4.7 (± 0.8) N = 62	27.5 (± 3.3) 6.9 (± 2.0) N = 8	31.3 (± 0) 10.7 (± 0) N = 1	27.8 (± 0.4) 7.1 (± 0.5) N = 4	
Spring, 2002	Chambers Cr.		25.5 (± 1.8) 5.4 (± 1.1) N = 17	28.9 (± 1.8) 8.0 (± 1.6) N = 206	30.3 (± 2.4) 9.8 (± 1.4) N = 2	29.9 (± 2.3) 8.7 (± 1.6) N = 2	32.3 (± 1.3) 11.2 (± 1.8) N = 8

Table 11. Average length and weight at age (± 1 SD) of spring-run ganaraska-strain steelhead at the Root River Steelhead Facility during 1995 to 2002.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Spring, 1995	Ganaraska	16.5 (± 1.3)	21.5 (± 2.3)	24.2 (± 2.2)	27.5 (± 1.7)	28.8 (± 1.2)	32.5 (± 0)
		1.5 (± 0.5)	3.3 (± 1.0)	5.0 (± 1.4)	7.2 (± 2.0)	8.0 (± 1.4)	12.5 (± 0)
		N = 30	len N = 68 wt N = 67	N = 81	N = 24	N = 23	N = 1
Spring, 1996	Ganaraska	16.6 (± 1.9)	23.5 (± 1.8)	25.1 (± 2.0)	26.7(± 1.9)	28.6 (± 1.5)	32.2 (± 0)
		1.7 (± 0.5)	4.7 (± 1.2)	5.7 (± 1.4)	7.1 (± 1.5)	8.7 (± 1.5)	12.5 (± 0)
		N = 57	N = 167	N = 113	N = 22	N = 29	N = 1
Spring, 1997	Ganaraska	15.1 (± 1.9)	23.5 (± 2.1)	28.4 (± 1.9)	27.7 (± 2.1)	27.1 (± 0)	
		1.2 (± 0.4)	4.3 (± 1.3)	7.9 (± 1.6)	7.4 (± 1.7)	6.7 (± 0)	
		N = 3	N = 75	N = 125	N = 30	N = 1	
Spring, 1998	Ganaraska	16.7 (± 1.3)	21.4 (± 1.9)	25.1 (± 2.6)	27.0 (± 0.8)	31.2 (± 0.2)	30.4 (± 0)
		1.6 (± 0.3)	3.3 (± 0.8)	5.2 (± 1.5)	5.9 (± 0.6)	9.3 (± 0.7)	4.9 (± 0)
		N = 45	N = 66	N = 94	N = 7	N = 3	N = 1
Spring, 1999	Ganaraska	17.1 (± 1.6)	23.7 (± 1.4)	26.2 (± 1.7)	27.6 (± 2.0)		
		2.0 (± 0.6)	4.9 (± 0.9)	6.6 (± 1.3)	7.4 (± 1.8)		
		N = 6	N = 167	N = 79	N = 25		
Spring, 2000	Ganaraska	16.8 (± 1.6)	25.1 (± 2.2)	28.6 (± 2.1)	28.3 (± 2.3)	29.4 (± 1.7)	
		1.6 (± 0.4)	5.8 (± 1.6)	8.3 (± 1.9)	8.2 (± 2.1)	9.0 (± 1.1)	
		N = 37	N = 73	N = 202	N = 18	N = 5	
Spring, 2001	Ganaraska	16.9 (± 0.6)	23.7 (± 1.5)	27.1 (± 2.4)	29.3 (± 1.0)	28.9 (± 1.3)	32.8 (± 0)
		1.6 (± 0.3)	4.7 (± 0.8)	7.0 (± 2.1)	9.0 (± 0.6)	8.7 (± 1.7)	12.5 (± 0)
		N = 14	N = 273	N = 18	N = 3	N = 4	N = 1
Spring, 2002	Ganaraska	16.0 (± 1.6)	23.2 (± 1.5)	27.3 (± 1.7)	28.1 (± 2.4)	28.9 (± 0.5)	
		1.5 (± 0.4)	4.2 (± 0.7)	7.1 (± 1.4)	8.0 (± 2.5)	8.1 (± 0.2)	
		N = 17	N = 86	N = 103	N = 5	N = 2	

Table 12. Population estimates for chinook, coho and steelhead salmon returning to the Root River during fall, 1994 through spring, 2002. Fall steelhead are mostly skamania, but may include other strains.

Year	Species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (+) 1 SD
Fall, 1994	Chinook	1,720	143	44	5,590 \pm 701
	Coho	513	2	0	-
	Fall steelhead	556	22	6	1,827 \pm 539
Spring, 1995	Chambers Creek	1,653	117	45	4,298 \pm 503
	Ganaraska	453	74	11	2,718 \pm 691
Fall, 1995	Chinook	2,663	36	21	4,478 \pm 594
	Coho	1,354	33	13	3,288 \pm 651
	Fall steelhead	482	36	6	2,547 \pm 811
Spring, 1996	Chambers Creek	1,045	48	28	1,765 \pm 206
	Ganaraska	1,457	77	31	3,551 \pm 475
Fall, 1996	Chinook	5,440	37	36	5,587 \pm 147
	Coho	3,940	9	9	3,940 \pm 0
	Fall steelhead	105	29	0	3,150 \pm 2,189
Spring, 1997	Chambers Creek	900	38	6	5,014 \pm 1,606
	Ganaraska	139	23	5	5,356 \pm 1,753
Fall, 1997	Chinook	3,974	40	31	5,127 \pm 436
	Coho	6,909	52	45	7,983 \pm 436
	Fall steelhead	228	16	2	1,297 \pm 509
Spring, 1998	Chambers Creek	93	15	2	501 \pm 226
	Ganaraska	217	17	1	1,962 \pm 1,067
Fall, 1998	Chinook	3,845	55	51	4,146 \pm 156
	Coho	3,336	25	19	4,389 \pm 493
	Fall steelhead	64	33	1	1,088 \pm 609
	Brown	202	31	11	539 \pm 118
Spring, 1999	Chambers Creek	678	-	-	-
	Ganaraska	1,043	-	-	-
Fall, 1999	Chinook	5,381	18	7	13,836 \pm 4,088
	Coho	978	111	35	3,101 \pm 434
	Fall steelhead	19	13	0	266 \pm 181
	Brown	125	17	2	750 \pm 342
Spring, 2000	Chambers Creek	460	1	0	-
	Ganaraska	1,006	21	13	1,625 \pm 278
Fall, 2000	Chinook	6,965	72	13	38,575 \pm 9,685
	Coho	2,921	38	11	10,091 \pm 2,565
	Fall steelhead	59	16	6	157 \pm 51
	Brown	241	22	1	2,771 \pm 1,529
Spring, 2001	Chambers Creek	128	8	2	384 \pm 157
	Ganaraska	475	27	6	2,137 \pm 769
Fall, 2001	Chinook	9,697	142	82	16,792 \pm 1,205
	Coho	942	2	1	1,413 \pm 471
	Fall steelhead	175	40	3	1,794 \pm 762
	Brown	176	71	1	6,336 \pm 3,607
Spring, 2002	Chambers Creek	564	15	9	940 \pm 198
	Ganaraska	372	14	9	579 \pm 115

Figure 1. Steelhead mean length-at-age at the Root River Steelhead Facility during 1994 to 2002. Skamania data from 2001 and 2002 were taken from fish transported and held at Kettle Moraine Springs Hatchery.

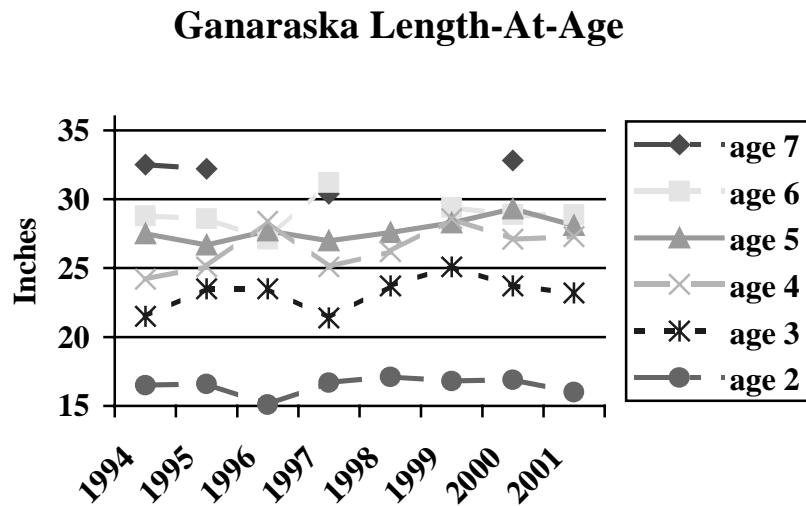
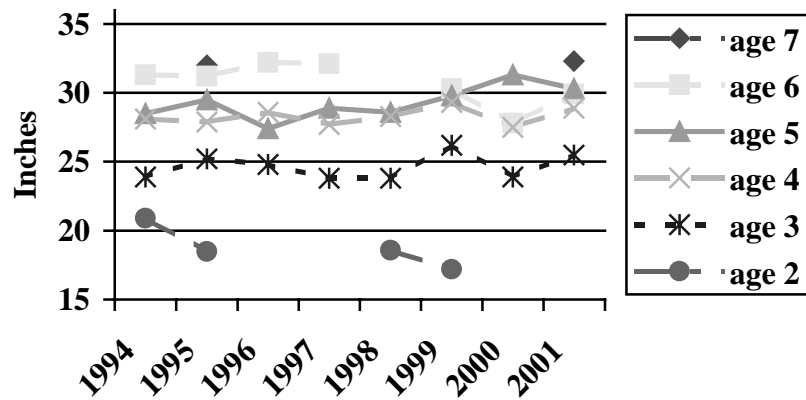
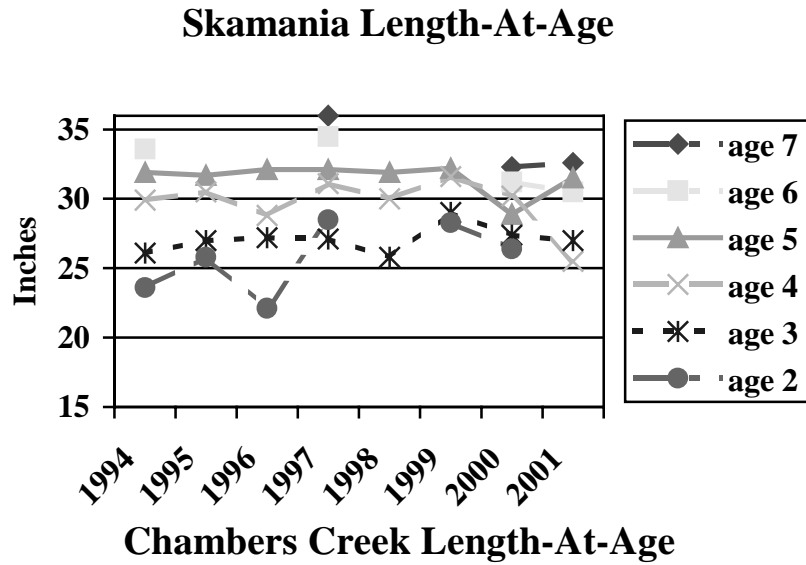
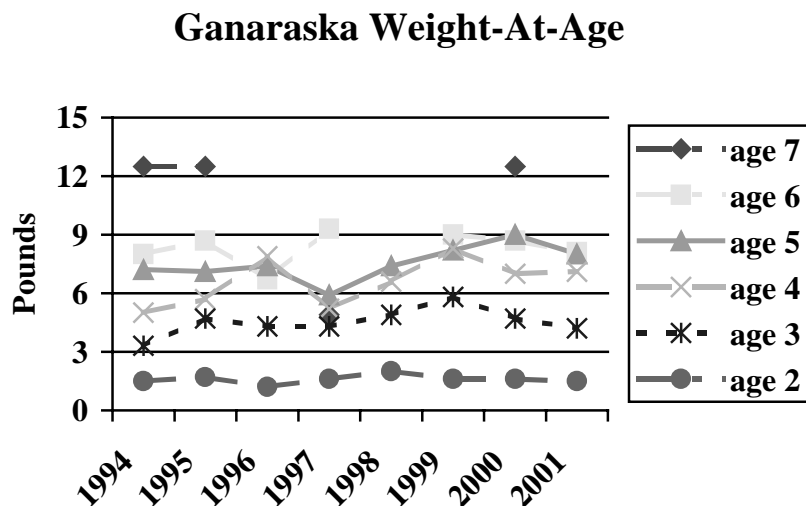
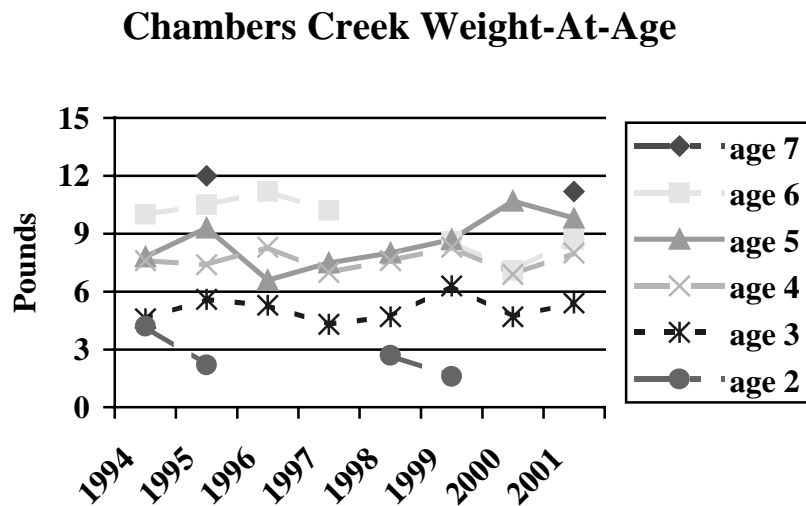
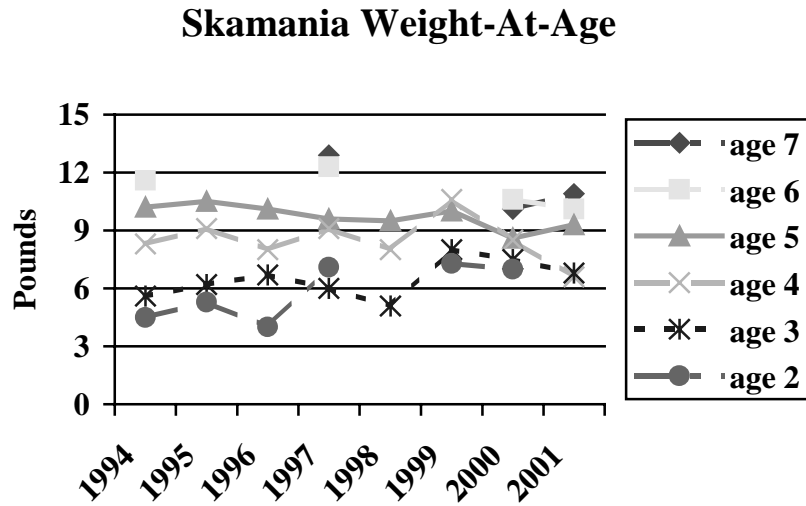


Figure 2. Steelhead mean weight-at-age at the Root River Steelhead Facility during 1994 to 2002. Skamania data from 2001 and 2002 were taken from fish transported and held at Kettle Moraine Springs Hatchery.



APPENDIX A. ROOT RIVER STOCKING NUMBERS

Table A-1. Number of fingerling chinook salmon stocked in the Root River during 1994 - 2001. Targets were 169,500, reduced to 143,900 after 1998. Chinook salmon were marked with an oral dose of Oxytetracycline (OTC) during 2001.

Year stocked	Total number	Strain	Fin clip
1994	75,533	Lake Michigan	LP
	60,000	Lake Michigan	None
1995	99,000	Lake Michigan	RP
	69,250	Lake Michigan	None
1996	158,000	Lake Michigan	None
1997	142,500	Lake Michigan	None
1998	161,500	Lake Michigan	None
1999	143,100	Lake Michigan	None
2000	142,900	Lake Michigan	None
2001	143,973	Lake Michigan	None (OTC)

Table A-2. Number of coho salmon stocked in the Root River during 1994 – 2001. Targets were 40,600 spring yearlings and 10,000 fall fingerlings.

Year stocked	Total number	Strain	Fin clip	Age
1994	66,080	Lake Ontario	None	Spring yearling 1+
	55,954	Lake Ontario	RMLP	Fall fingerling 0+
	50,389	Lake Michigan	RP	Spring yearling 1+
1995	65,100	Lake Michigan	RMRP	Spring yearling 1+
	54,832	Lake Michigan	RMLV	Fall fingerling 0+
1996	40,590	Lake Michigan	RMRV	Spring yearling 1+
	63,697	Lake Michigan	LP	Fall fingerling 0+
1997	48,107	Lake Michigan	RP	Spring yearling 1+
	6,668	Lake Michigan	REL	Spring yearling 1+
	4,208	Lake Michigan	None	Spring yearling 1+
	20,604	Lake Michigan	None	Fall fingerling 0+
1998	33,666	Lake Michigan	None	Spring yearling 1+
	10,000	Lake Michigan	None	Fall fingerling 0+
1999	45,945	Lake Michigan	None	Spring yearling 1+
	13,824	Lake Michigan	None	Fall fingerling 0+
2000	41,375	Lake Michigan	None	Spring yearling 1+
	10,030	Lake Michigan	None	Fall fingerling 0+
2001	27,970	Lake Michigan	None	Spring yearling 1+
	11,080	Lake Michigan	A-CWT	Spring yearling 1+
	10,260	Lake Michigan	None	Fall fingerling 0+

Table A-3. Number of steelhead stocked in the Root River during 1994 – 2001. Stocking targets were 35,000 per strain, reduced to 27,000 chambers creek and ganaraska after 1998.

Year stocked	Total number	Strain	Fin clip
1994	30,417	Skamania	RM
	35,124	Chambers Creek	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Creek	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Creek	LM
	35,404	Ganaraska	ARV
1997	35,262	Skamania	RMRV
	35,024	Chambers Creek	LMLV
	35,201	Ganaraska	BV
1998	37,484	Skamania	ARM
	33,187	Chambers Creek	ALM
	33,548	Ganaraska	ALV
1999	35,528	Skamania	RM
	26,951	Chambers Creek	LM
	26,963	Ganaraska	ARV
2000	37,010	Skamania	RMRV
	27,287	Chambers Creek	LMLV
	27,118	Ganaraska	BV
2001	35,247	Skamania	ARM
	27,060	Chambers Creek	ALM
	27,100	Ganaraska	ALV



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